Salvage Flexor Hallucis Longus Transfer for a Failed Achilles Repair: Endoscopic Technique

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Abstract: Flexor hallucis longus (FHL) transfer is a well-established treatment option in failed Achilles tendon (AT) repair and has been routinely performed as an open procedure. We detail the surgical steps needed to perform an arthroscopic transfer of the FHL for a chronic AT rupture. The FHL tendon is harvested as it enters in its tunnel beneath the sustentaculum tali; a tunnel is then drilled in the calcaneus as near to the AT footprint as possible. By use of a suture-passing device, the free end of the FHL is advanced to the plantar aspect of the foot. After adequate tension is applied to the construct, the tendon is fixed in place with an interference screw in an inside-out fashion. This minimally invasive approach is a safe and valid alternative to classic open procedures with the obvious advantages of preserving the soft-tissue envelope and using a biologically intact tendon.

The incidence rates of Achilles tendon (AT) rerupture after primary surgical repair vary widely in the literature.[1,2] Several treatment options exist, such as V-Y advancement and the Bosworth turn-down repair.[3] Other surgical techniques use tendon transfers of the peroneus brevis, flexor digitorum longus, and flexor hallucis longus (FHL). The use of an FHL transfer has been proposed[4,5] because it is a stronger plantar flexor, its axis of contractile force more closely reproduces that of the AT, it fires in phase with the gastrocnemius-soleus complex, and its anatomic proximity avoids iatrogenic lesions of the neurovascular bundle. Another benefit of FHL transfer is plantar flexion strength reinforcement, which is almost always compromised with fascial advancement alone.[6] Regarding vascularization of the AT, the FHL muscle belly extends distally into the avascular zone of the AT and allows recruitment of an increased blood supply to the repaired AT. Furthermore, FHL transfer maintains the normal muscle balance of the ankle by transferring a muscle with the same function. In a recent study using magnetic resonance imaging evaluation, Hahn et al.[4] showed complete integration of the FHL tendon in 60% of patients and hypertrophy of the FHL of more than 15% was observed in 80% of patients.

Case Description

We present the case of a 34-year-old man with no known pathology and an irrelevant medical history and habits. He was a recreational sports participant and sustained an AT rupture. Primary surgery was performed 2 weeks after the initial trauma by a minimally invasive technique (Achillon System; Integra LifeSciences, Plainsboro, NJ). The patient began physical therapy after 3 weeks of equinus cast immobilization and had good progression until 12 weeks postoperatively, when a rerupture occurred while he was working out on a treadmill. The patient then underwent reoperation with the technique described in this report.

Surgical Technique

Posterior ankle endoscopy is performed in a standard fashion.[7] The patient lies prone, and a 2-portal technique using the posterolateral and posteromedial portals is performed (Fig 1). The posterolateral portal is primarily used as the viewing portal, and the posteromedial portal is used as the instrumentation portal. The essential surgical steps are depicted in a right ankle in Video 1. The FHL tendon is identified after debridement and clearing using a shaver (3.5-mm Great White; ConMed, Utica, NY) and a

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Fig 1. (A) The patient lies prone with a small gel support under the lower leg, and a tourniquet is applied to the thigh and inflated to 300 mm Hg. (B) The posterolateral and posteromedial portals are located just above a horizontal line connecting the lateral malleolus and the Achilles tendon.

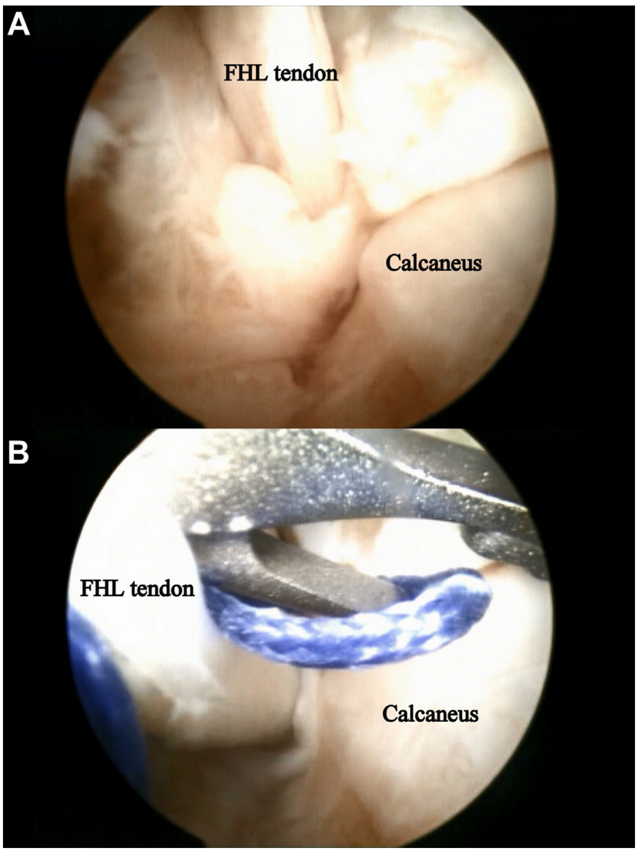

Fig 2. (A) After debridement and clearing, the flexor hallucis longus (FHL) lies medially to the talus, entering the fibro-osseous tunnel. (B) The FHL tendon is pierced with a suture passer, and a lasso loop–type suture is tied to provide traction on the tendon.

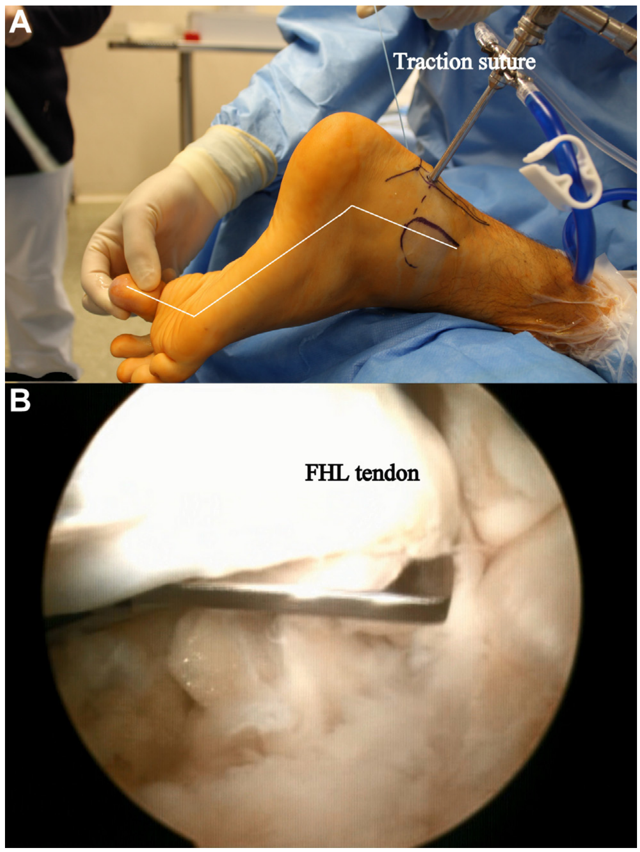

Fig 3. (A) The foot is held in plantar flexion with the hallux flexed, relaxing the flexor hallucis longus (FHL), and the traction suture is grasped and gently pulled, allowing for as distal a tenotomy as possible. The white line depicts the intended position. (B) Tenotomy is performed with arthroscopic scissors while the foot is maintained in the aforementioned position.

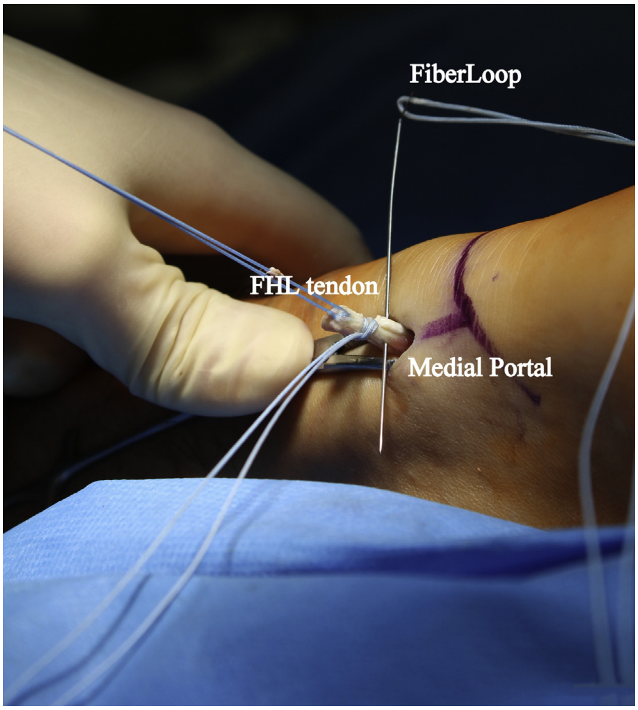

Fig 4. The flexor hallucis longus (FHL) tendon is brought outside through the medial portal while the surgeon is pulling on the traction suture; a Krackow-type suture is then applied on its distal end, providing adequate fixation for further manipulation.

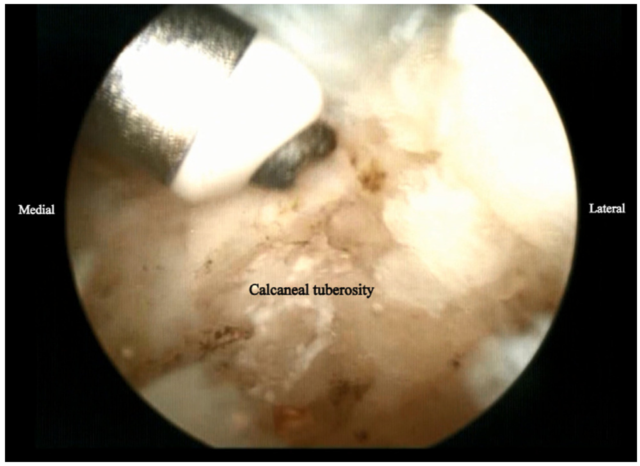

Fig 5. The intended footprint is as close to the anatomic footprint as possible, on the medial aspect of the middle facet of the calcaneal tuberosity. By use of adequate instrumentation, this area is cleared of soft tissue and the bone bed is prepared.

radiofrequency wand (Arthroscopic Energy 50° Probe with Suction; ConMed); it lies medial to the talus and is clearly visible until entering the fibro-osseous tunnel. The FHL tendon is pierced with a suture passer (Suture Tram; ConMed), and a lasso loop–type suture is tied using a nonabsorbable suture (FiberWire; Arthrex, Naples, FL); this provides traction on the tendon (Fig 2). While the hallux is flexed and the foot is held in plantar flexion, the traction suture is grasped and gently pulled; a tenotomy is then performed using arthroscopic scissors (2.75-mm-diameter, straight; ConMed) and completed with a radiofrequency wand, aiming to obtain the maximum length of tendon possible (Fig 3). The free end of the

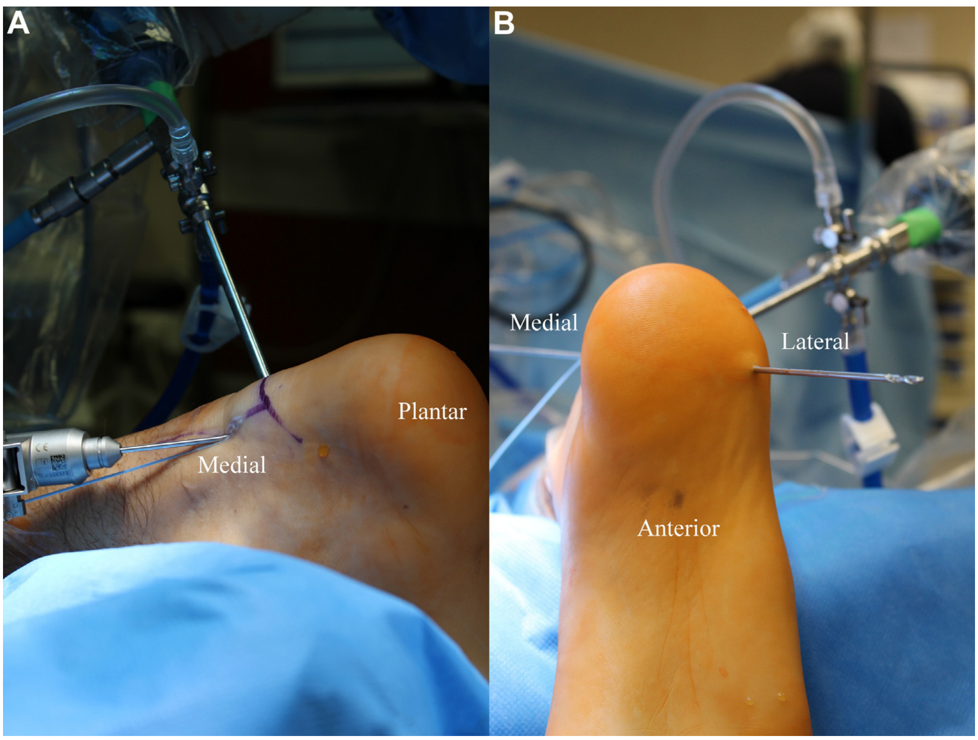

Fig 6. The suture-passing wire is advanced through the calcaneus. (A) Entering from the medial portal, the wire forms an approximately 15° angle with the plantar aspect of the foot. (B) The plantar exit point should be lateral so that adequate bone stock is available for overdrilling.

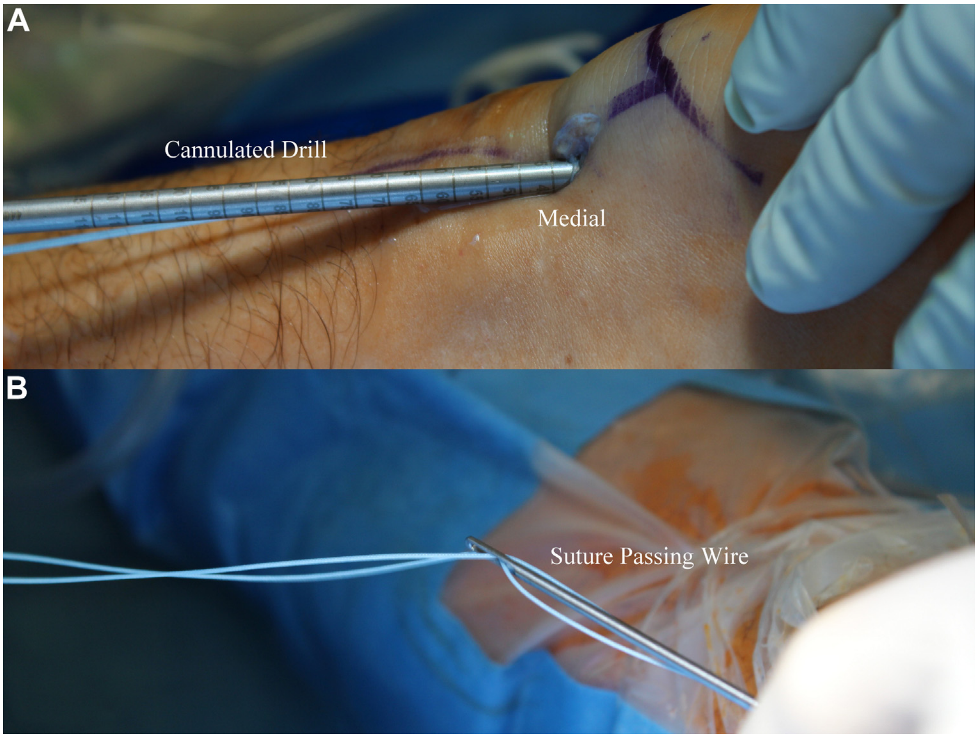

Fig 7. (A) The 4.5-mm cannulated drill is advanced over the suture-passing wire and is drilled to a depth of 30 mm. (B) After over-drilling is completed, the Krackow suture ends are passed through the hole in the wire eyelet and the wire is fully advanced to the plantar aspect of the foot.

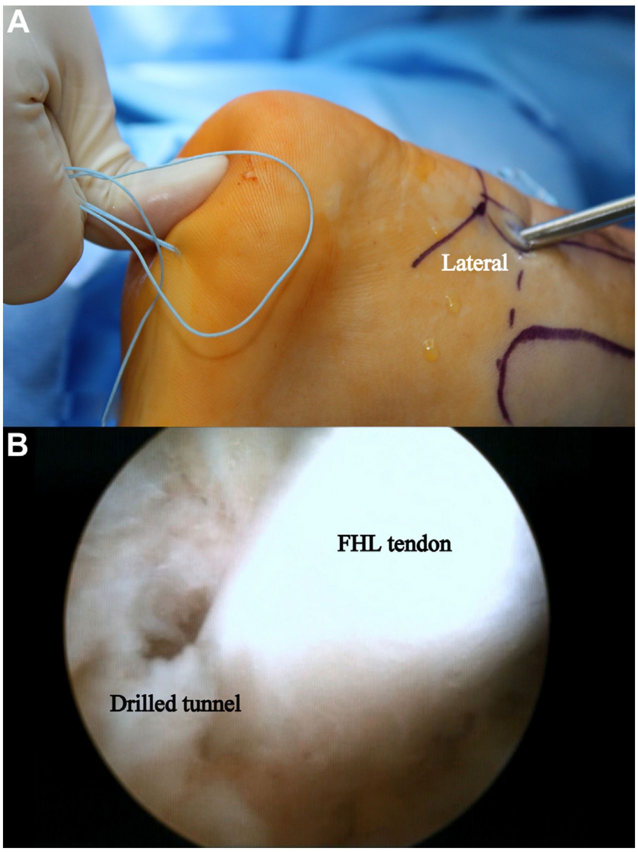

Fig 8. (A) While the surgeon is grasping the loose ends of the Krackow suture, tension is applied, forcing the free end of the flexor hallucis longus (FHL) inside the previously drilled tunnel. (B) The desired position before final fixation with the interference screw should leave the foot resting in a neutral position or slight dorsiflexion.

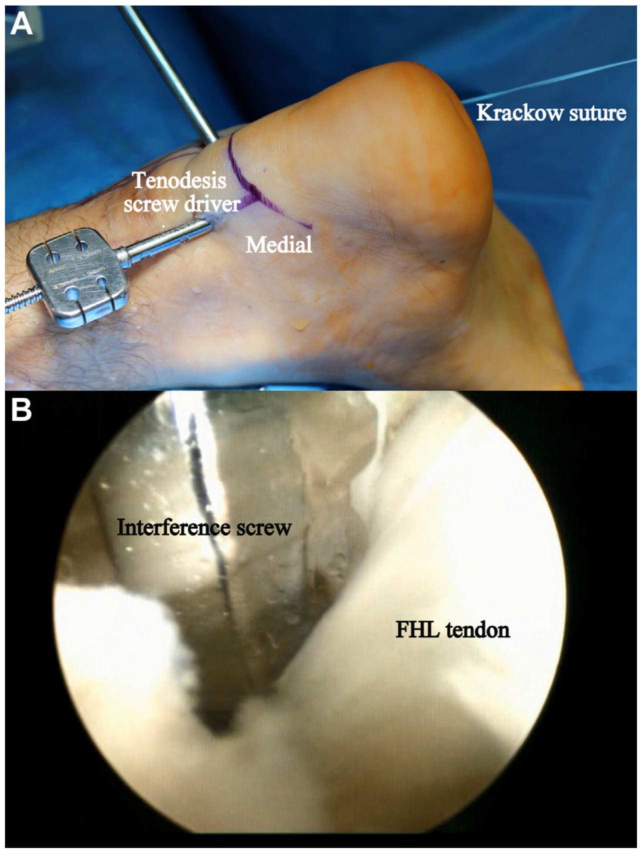

Fig 9. (A) A 5.5-mm screw is advanced from the medial portal after taping while adequate tension is maintained on the free end of the Krackow suture. (B) A snug fit between the flexor hallucis longus (FHL) and the bone tunnel is key for securing the final construct.

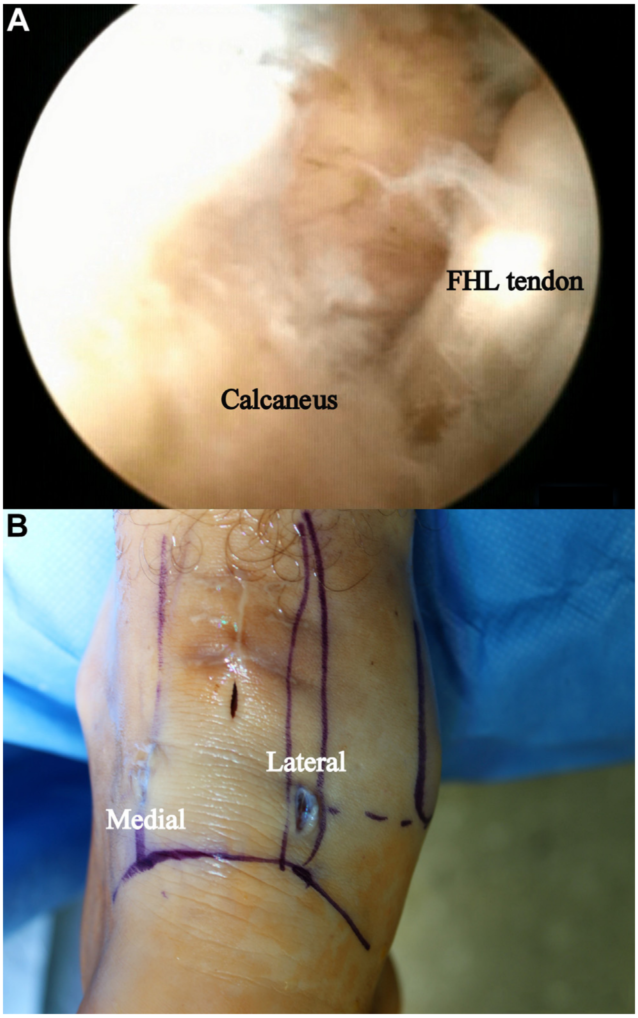

Fig 10. Final position of construct as viewed from (A) posterior and (B) lateral portals.

Table 1. Pearls and Pitfalls

Tendon harvest
Pearls
Foot positioning is crucial for relaxing the FHL; this allows a very distal harvest.
Gentle traction on the stay suture further exposes the FHL.
Pitfalls
Failing to obtain enough length of the FHL tendon complicates manipulation.
The tibial nerve runs just medial to the FHL tendon; caution is to be observed.
Tunnel placement
Pearls
Suture-passing wire is used as a guide for tunnel placement, entering from the medial portal.
The wire forms an approximately 15° angle with the plantar aspect of the foot, and the plantar exit point should be lateral.
Pitfall
A straight tunnel puts the medial wall of the calcaneus at risk during drilling.
Fixation
Pearl
Adequate tension should be maintained on the FHL traction suture while advancing the screw; an assistant can hold the arthroscope while the surgeon controls the tension to provide fine-tuning.
Pitfall
Failure to provide adequate interference can result from buckling of the tunnel walls; in this case, the screw diameter can be increased.

FHL, flexor hallucis longus.

FHL tendon is exteriorized through the medial portal using the traction suture. A Krackow-type suture with a nonabsorbable wire (FiberLoop; Arthrex) is applied on the distal end of the FHL and will allow for its shuttling through the calcaneal tunnel, as well as adequate grasping for tensioning before final fixation (Fig 4).

The intended footprint for the calcaneus tunnel placement is cleared to the bone; a medial insertion site is chosen to closely resemble the AT anatomic footprint[8] on the medial aspect of the middle facet of the calcaneal tuberosity (Fig 5). It is important to advance the suture-passing wire (Arthrex) in a medial to lateral direction and at an approximately 15° angle to the plantar aspect of the foot (Fig 6). This direction of the planned tunnel placement provides adequate bone coverage for graft integration. The cannulated reamer (4.5-mm Drill Bit from Bio-tenodesis Screw System; Arthrex) is then advanced through the medial portal, sliding over the suture-passing wire; while the surgeon is viewing from the lateral portal, the tunnel is reamed to a depth of 30 mm (Fig 7A). After the reamer is removed with care taken to avoid removing the suture-passing wire, the free ends of the Krackow suture are passed through the eyelet and the wire is fully advanced to the plantar aspect of the foot (Fig 7B). Grasping the suture allows for full advancement of the tendon's free edge inside the tunnel; moving the foot through its range of motion permits the surgeon to select adequate tension before final fixation so that the foot is resting in a neutral position or slight dorsiflexion (Fig 8). While the desired tension is held on the Krackow suture, the screw (BioComposite Tenodesis Screw, 5.5 mm × 15 mm; Arthrex) mounted on the driver (driver for 15-mm tenodesis screws from Bio-tenodesis Screw System) is advanced through the medial portal over the guidewire (Fig 9A). A good fit between the tendon, tunnel, and screw is expected, and the security of the final construct should be tested with a range of motion and palpation with a hook while the surgeon is viewing from the lateral portal (Fig 9B). The surgeon should evaluate the final result from posterior and lateral, confirming the desired foot position and using an arthroscope (Fig 10).

An equinus posterior splint immobilization is applied for 4 weeks postoperatively, and non—weight-bearing range-of-motion exercises are encouraged for another 4 weeks. After this period, full weight bearing as tolerated is advocated.

Discussion

A chronic degenerated AT tendon is expected in a rerupture with a compromised biological value. Thus the use of a biologically intact tendon through its transfer is an appealing option. There is evidence that tenocytes from ruptured ATs produce greater quantities of type III collagen and have different protein and gene expression profiles than normal ATs.[9] This altered production of collagen may result in the tendon being less resistant to tensile forces and, thus, at increased risk of rupture.[10] As for the FHL harvest, transfer morbidity is clinically insignificant, even for good push-off or balance in running sports.[11] Our minimally invasive technique for achieving FHL transfer further eliminates morbidity from this procedure, such as wound healing–related problems (Table 1). It is a safe and valid alternative to classic open procedures with a good expected clinical outcome.

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